



NATIONAL RADIO ASTRONOMY OBSERVATORY

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Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of)	
)	
Revision of the Commission's Rules Regarding)	ET Docket No. 07-113
Operation in the 57-64 GHz band)	RM-11104

Comments of the
National Radio Astronomy Observatory
Charlottesville, VA 22903

I. Introduction; Interference Concerns

1. The National Radio Astronomy Observatory (NRAO) is pleased to provide comments responding to the Commission's Notice of Proposed Rule Making, FCC 07-104 ("the NPRM"), regarding revision of the rules for unlicensed operations in the 57 – 64 GHz band.
2. NRAO (<http://www.nrao.edu>), operated by Associated Universities, Inc., (<http://www.aui.edu>) under a cooperative agreement with the National Science Foundation, is the largest radio astronomy observatory and one of the largest astronomical observatories of any kind in the world. It operates stations within the National Radio Quiet Zone and in one dozen rural locations within the United States, several of which stand to be affected by the Part 15.255 of the Commission's rules governing operation of unlicensed devices in the 57 – 64 GHz band. NRAO was the world pioneer in astronomical usage of the mm-wave spectrum 40 years ago. NRAO maintains a strong mm-wave research and development program and has great interest in continued successful astronomical operations at mm-wavelengths throughout the United States.
3. Since the Commission formulated the Rule Part 15.225 under which unlicensed devices operate in the 57 – 64 GHz band, the radio astronomy service has been granted primary allocations at higher frequencies which overlap the low-order harmonics of portions of the 57 – 64 GHz band. The affected radio astronomy bands (see 4 here) contain the two most accessible spectral lines of carbon monoxide, which is the most

heavily-studied molecule in interstellar space. The value of these 115 and 230 GHz bands to radio astronomy is inestimable.

4. Spectral overlap between low order harmonics of the 57 - 64 GHz band and protected radio astronomy bands is shown in Table 1 below which gives; the protected radio astronomy bands, their status under footnote US 246 ("No station shall be authorized to transmit in the following bands...") and the sub-band of which the protected bands are a 2nd, 3rd or 4th harmonic.

TABLE 1
HARMONICS FALLING IN RADIO ASTRONOMY BANDS

RAS BAND (G H z)	US246?	H A R M O N I C - O F			
		2 ND	3 RD	4 TH	
111.8-114.25		55.9 - 57.13			
114.25 - 116	YES	57.13 - 58.0			
182 - 185	YES		60.67-61.67		
226 - 231.5	YES			56.5-57.88	

5. Unlike fundamental frequencies within the 57 - 64 GHz band, the spurious emissions which could constitute detrimental interference to radio astronomy propagate relatively free of attenuation by the atmosphere around a radio astronomy site, else they could not be observed there.

II. Possible Effects of Unwanted Emissions

6. The Commission proposes to convert the existing flux density limit on spurious emissions in the band 40 - 200 GHz to an equivalent EIRP value -10 dBm (NPRM Part 15.225 (c) (3), revised). Below at 9 NRAO suggests that the FCC should extend the limit on spurious emissions upward to cover the protected radio astronomy bands at 226 - 231.5 GHz.
7. Threshold levels of interference (dBW/m²) detrimental to radio astronomy observations are given in column 8 of Tables 1 and 2 of ITU-R Recommendation RA. 769-2 for continuum and spectral line observations, respectively. At 115, 183 and 230 GHz the dominant radio astronomy use is for spectral line observations and the relevant thresholds (interpolated in frequency) are given in Table 2 below. From these thresholds and the Commission's proposed EIRP limit on spurious emissions, -10 dBm, a separation distance for avoidance of detrimental interference is implied once the propagation loss is known. Table 2 gives three values corresponding to propagation in free space, dry air and typically wet air as described in ITU-R Recommendation P. 676-6, Annex 2, Table 5. The best observing conditions at elevated astronomy sites approach the dry air case.

TABLE 2
FREQUENCIES, THRESHOLDS AND SEPARATION DISTANCES

FREQUENCY G H Z	RA. 769 dBW/M ²	DISTANCES		
		FREE SPACE KM	DRY KM	WET KM
115	-146	56.3	36.8	17.2
183	-142	35.5	34.1	5.4
228	-139	25.1	24.2	5.0

8. Free space separation distances for continuum observations are almost exactly ten times smaller in radius, a few km in each case, and differences between the free space and wet air separation distances are much less pronounced. Note that the far field regime of a 10m radio astronomy antenna operating at 115 GHz (2.61 mm wavelength) begins at $2D^2/\lambda = 76.6$ km. Interference from multiple Part 15.255 devices could aggregate, increasing the required separation distances.

III. Suggested Relief

9. The Commission has proposed that Part 15.255 limits on spurious emissions continue to extend over the band 40 - 200 GHz (NPRM Part 15.255 (c) 3). To protect radio astronomy operations in the band near 230 GHz (Table 1), NRAO suggests that the Commission should extend this range upward at least to 232 GHz. Such limitations on consideration of out of band emissions, to 200 GHz or below, occur in other FCC rule parts such as 15.523(h) and may need to be revisited more generally as requests for unlicensed use proliferate at ever-higher frequencies.
10. Absent other considerations such as terrain shielding (but see 11 & 12 here), Part 15.255 unlicensed devices using the 57 – 64 GHz band should not be allowed to operate in the vicinity of radio astronomy stations which observe at frequencies in the protected bands near 115, 183 and/or 230 GHz (Table 1). Within distances comparable to those noted in Table 2 here the propagation loss of spurious emissions (in air) at levels proposed by the Commission is not sufficient to prevent interference detrimental to radio astronomy observations on a single-entry basis.
11. As shown in Table 1 here, harmonic interference into the radio astronomy bands near 115 and 230 GHz might be precluded by excluding the sub-band 57 – 58 GHz from Part 15.255 operation. Because the 183 GHz band is useful to radio astronomy only from the few very best sites (see 12) this could be a *complete* remedy for most radio astronomy stations operating at mm-wave frequencies.
12. Harmonics of Part 15.255 operations above 58 GHz affect only the protected 182-185 GHz band. In the US, this band is useful for radio astronomy at only a few very superior high sites having exceptionally small overlying columns of water vapor, that is at CARMA (CA), Mt. Graham (AZ) and Mauna Kea (HI); see US 388. 57-64 GHz Part 15.255 operations should be avoided near these very isolated sites to which astronomers have repaired to obtain the very best observing conditions, but otherwise

could perhaps be coordinated on an individual basis, considering the specifics of local terrain shielding, *etc.*

Respectfully submitted,

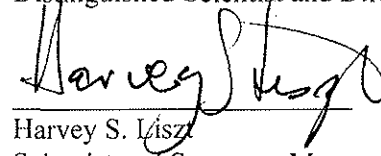
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